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# Contribution of the Wild Food Plants in the Food System of Tribal Belt of Pakistan; The Pak - Afghan Border Region

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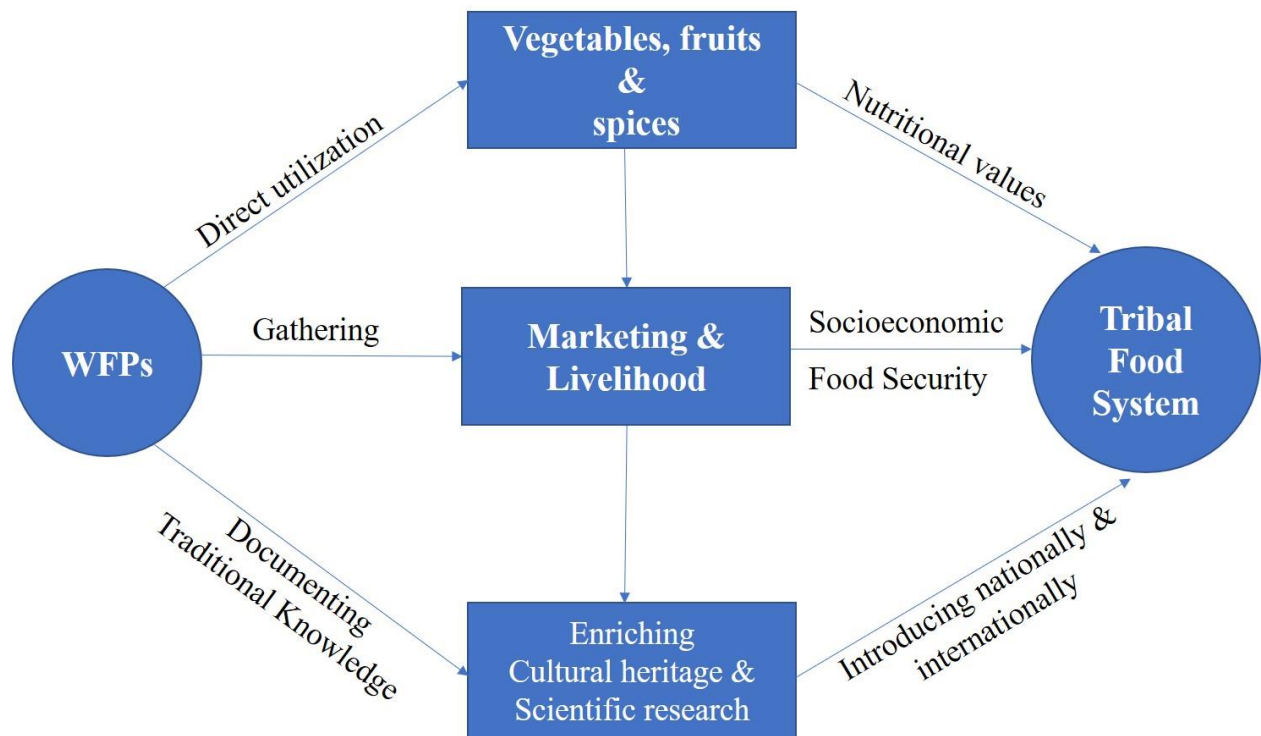
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**Abstract:** The tribal belt of Pakistan-the Pak-Afghan border region is famous for its unique culture, ethnography and wild food plants and traditional knowledge. People of these regions gather wild plants for number of purposes including plants or plant parts for direct use, use it in the traditional cuisines and selling in local markets. However, there is huge lack of documentation of food system particularly the Wild Food Plants (WFPs). In current study we have focused on the uses and contributions of the WFPs in the tribal traditional food system. The ethnobotanical data were gathered through questionnaire surveys with Eighty-four informants 69 men and 15 women belonging to 21 different villages. We documented Sixty-three WFP species belonging to 34 botanical families, of which 27 were used as vegetables, 24 as fruits, 6 in different kinds of chutneys (starters) formation and six as fresh food species. Fruits were the mostly used part (40%) followed by leaves (24%), aerial parts (24%), seeds (7%), stem (3%), legume (2%) and young inflorescence (1%). Use of *Carthamus oxycanthus* & *Pinus roxburghii* seeds and *Marsillea quadrifolia* leaves were the novel reports for the gastronomy of Pakistan. The results elucidate that WFPs have a significant contribution in the Tribal Food Systems. Tribal people use WFPs not only due to their nutritional importance but also as a cultural practice - an inseparable component of the tribal communities. This important traditional Knowledge about the consumption of WFPs has been eroding with an alarming speed among the younger generations due to introduction of fast food chains, modernization, and globalization. Therefore, appropriate strategies are imperative not only to safeguard traditional knowledge but also the cultural heritage, food security and hence public healthcare via food supplement in the region.

**Keywords:** gastronomy; livelihood; public healthcare; traditional knowledge; wild food plants; tribal belt

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Graphical abstract representing contributions of WFPs in the Tribal Food System.

## 1. Introduction

Wild Food Plants (WFPs) have a crucial role in the food system since the beginning of human civilization [1]. Wild food plants refer to the plant species that are gathered or harvested by indigenous communities from their surrounding ecosystem and used in the human food system [2]. Ecosystems in the tribal belt is varied and comprise fields, forests and pastures; give rise to variety of wild fruits and vegetables [3]. These WFPs are not only important from nutritional point of view but also have important medicinal values [4,5] some of which have been evaluated for its pharmacological screening in many other parts of the world [5-7]. In current era, number of WFPs are being identified as “functional foods”. They provide healthy diets and could contribute in prevention of some of the major ailments [8,9]. It is also confirmed by researchers that most of them are rich source of bioactive compounds such as essential Fatty Acids, Vitamins and complex sugars [9-11] and can contribute significantly in the mitigation of malnutrition [3]. Its importance is crucially emphasized in income generation, poverty reduction, nutritional balance, ensuring food security and agricultural diversification by number of studies [12,13]. One of the major contribution of WFPs is in food security that also offer alternate source and diversity in the food system of traditional communities [14]. They play a crucial role in human survival during famine [15] and food shortages such as during COVID-19 pandemic crisis, Geopolitical and Tribal Wars of Pakistan especially in these border regions.

Pakistan is the 6<sup>th</sup> most populous and lower middle-income country in the world [16] gifted with four seasons and great diversity of natural resources [17] but still ranked top 11<sup>th</sup> developing country facing the issues of food security [18]. According to research [16] about 60 % people of the country are insecure in terms of food. Food insecurities increase in the tribal belt of the country due to conflicts and prevailing dry climate. Pak Afghan border has always been center of tension due to its geopolitical position. Manmade catastrophes, dramatic increase in the human population, least access to food, local livelihood strategies and severe climate are the other major reasons of food insecurities and poverty in the tribal belt [19]. WFPs are one of the important sources for local poor communities that can help them to get rid of hunger and malnutrition. A very little work has been done on the wild vegetables and fruits species used in the food system of Pakistan in general and Pak-Afghan border regions in particular that can be seen in few of the studies referred here

[14,17,20-26]. Abbasi et al., [27] book on the ethnobotanical and nutraceutical aspects of the Wild Edible Vegetables of the Lesser Himalayas is one of the major contribution in this regard.

### *Tribal culture*

People of the region practice and enjoy a centuries old culture known as Pashtunwali or Pukhtunwali. Pashtunwali is very common cultural heritage of the tribal communities living along the Pak-Afghan border. It is a way of their life or legal social code of conduct that governs their life. According to [28] it is a 2000-3000 BC old tradition remains the central pillar of tribal societies. In this era of modernization Pashtunwali perceived as culturally idiosyncratic that significantly influence the perceptions, behaviors and thoughts in the daily life [29,30]. Code of honor (Nang) Hospitality (Melmastia) and revenge (Badal) are the three core pillars of Pashtunwali [31]. Code of honor or self-respect and dignity is a basic nature and character of Pashtun society. Melmastia is a sum of conventions and an immediate reward from the local societies regarding local cultural values while Badal in Pashtun society is just like a debt which ends on the revenge. These three cultural customs are the sum of the tribal communal expectations from the members of their own societies and as well as from outsider members [32]. The tribal belt of Pakistan - Areas of Pak-Afghan border is also well known for its unique traditional food system but up to date has not been explored by researchers in terms to document the precious traditional knowledge about the WFPs. Bajaur area is the most populous, climatically varied and ethnographically rich in the tribal belt depicts the culture and traditional knowledge of the whole Pak-Afghan border and hence been selected for current studies. It is region of relatively dry valleys in the Hindu Kush Mountain Ranges. As for as food system in the tribal belt especially the area under discussion is concerned, it's worth to mention that people are poor and most of the time utilize local food resources using their traditional knowledge. There is a negligible trend of hoteling an eating outside in the restaurants or other food points. It strengthens the ties of people with wild food resources including WFPs. Climate being one of the main drivers affecting all walks of life including wild food and food systems, bring considerable variations in different units/Tehsil of the studied area i.e Barang in the South, Nawagai and Chamrkand in the South west, Mamund, Salarzai and Utmankhel tehsils in the North and North east. The local communities collect wild vegetables and fruits from the side valleys, mountains and cultivated fields mostly during the collection seasons of the year. They know the best and suitable gathering seasons of wild vegetables using Traditional Ecological Knowledge (TEK). The women usually cook them on the traditional tribal styles. The demand of wild vegetables and fruits increases in various seasons when the cultivated fruits and vegetables are not available. Keep in mind the importance of WFPs in the food system of the tribal communities of the tribal regions current study was designed to (1) document WFPs diversity gathered and consumed by tribal communities (2) assess traditional knowledge about WFPs, their role and contribution in the nutrition as well as traditional tribal food system.

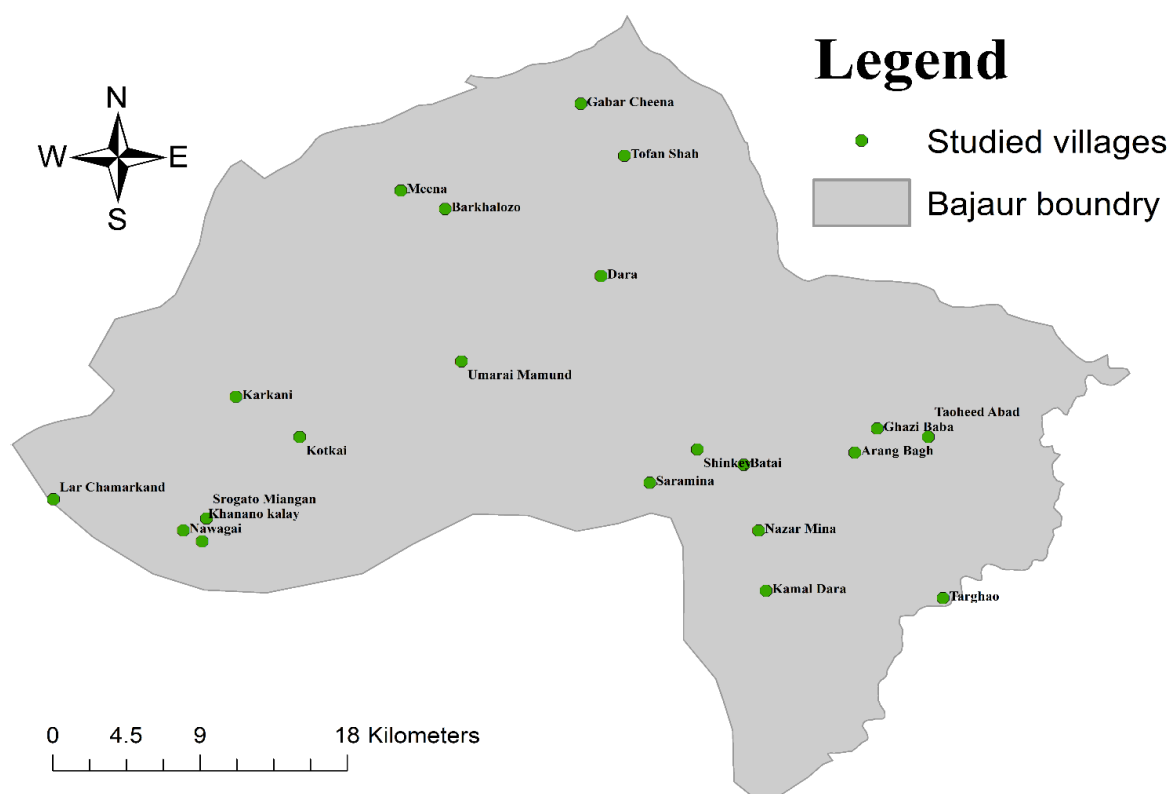
## **2. Methodology**

### *2.2. Study area*

District Bajaur is a tribal area remained part of Federally Administered Tribal Areas (FATA) up to 2018. The tribal areas of Pakistan form a long narrow belt along the historical border Durand line (Pak-Afghan border) - named after Sir Mortimor Durand in 1890-1894 who surveyed and established this borderline between Afghanistan and British India. Ex-FATA comprised of six Frontier Regions (FR), i.e., Kohat, Bannu, Tank, Dera Ismaiel Khan, Peshawar and Lakki Marwat and seven agencies namely Bajaur, Mohmand, Khyber, Orakzai, Kurram, North Waziristan and South Waziristan. According to researchers [33] the British in the mid of 19<sup>th</sup> century faced with difficulties and challenges in tax collection and effective control over the tribal belt and thus devised a legal and administrative systems known as Criminal Tribes Act - 1871. The law was "designed "for the registration, surveillance and control of certain tribes" [34] that was later on enacted under the name of Frontier Crimes Regulation (FCR). It remained effective in the tribal belt

till 2018. Government of Pakistan in 2018 merged the whole tribal belt of FATA in the mainstream of province of Khyber Pakhtunkhwa with a hope to bring harmony and development in accordance with the constitution of Pakistan. The area selected for current study is a mountainous territory with 1296 Km<sup>2</sup> area situated in the North western border of Pakistan and can be located at 34-51°N latitude and 71-31°E longitudes [35]. It shared 52 Km long border with Afghanistan west of Panjkora River hosting three important passes i.e., Nawa Pass, Ghakhi Pass and Letaisar [36]. These three passes play a significant role in the trade and sharing of traditional knowledge between both the countries. The research area is mainly inhabited by Utmankhel and Tarkanri tribes. The Utmankhel tribe lies in the South East bordering the districts of Malakand while the Tarkanri tribe lies in the Northwest on the Pak-Afghan border speak different dialects of Pashto. The Utmankhel tribe divides into sub-tribes of Alizai, Shamoza, Aseel, Gharshamoza and Mandal. The Tarkanri tribe comprised sub-tribes Mamund, Salarzai, Safi, Khalji and other sub-ethnic groups lives in the Ex-state of Khar [37]. According to [38] the Utmankhels are the descendants of Kirlan tribe of Waziristan who migrated to the valleys of Arang and Barang in Bajaur during 12<sup>th</sup> century. On the other hand, Tarkanri peoples are the descendants of Afghani Pashtuns. Before 9/11 people of both areas used to visit both the countries easily for various purposes. In short there is great impact of Afghan culture on the Tarkanri people. Most of the people live in rural parts of the area (Figure 1).

The district is gifted with number of other natural resources such as Nawagai, Inzaray, Arang, Barang and especially K-More mountain host different kinds of marble stones and many other minerals as well. Local communities involve in the extraction of marble, limestone, manganese, chromite and talc etc. Geographically, the study area lies in the extreme end of the Hindukush mountain range which creates considerable disparity and uncertainty in the pattern of monsoon rains from year to year. Climate of the district varies from extreme hot to bitter cold while travelling from the South-east to North-west. Weather remains pleasant, for most of the summer but the temperature drops below freezing during winter. The area receives about 800 mm of annual rainfall. Variation in the climatic conditions of the area leads to significant diversity of plants and hence WFPs. People are mostly farmers, few others are teachers, drivers, cobblers, businesses men etc by profession. A considerable number of local peoples work in other parts of the country or abroad and obtain remittances for their livelihood.



**Figure 1.** Map of the study area showing 21 studied villages.

### 2.3. Data Collection

In the current study 21 different villages were selected for interviews and gathering data on WFPs (Table 1). Two visits were made for this purpose from March 2016 till November. Interviews were conducted following the International Society of Ethnobiology Code of Ethics and the American Anthropological Association Code of Ethics [39]. Knowledgeable informants were selected through Snowball sampling methods [40-42]. A total of Eighty-four informants in total were interviewed (four from each village) including 69 men and 15 women (Table 2). The informant ages ranged from 17-85 years (Table 2) who were interviewed in Pashto language. Participants were asked about local names, part used, collection time, recipes and mode of utilization, use in other cuisines, sale or marketing of the WFPs species they gathered and still gathering [42]. The first author belongs to study area and has family ties with few of the villages studied. It helped a lot in gathering data about uses of WFPs and selection of the informants.

The interviewees were asked about the **settlement they live in**, age, place of **birth** and occupation. They were **further** asked (1) what wild vegetables species **they** collect? (2) what wild fruits species they collect **and use for**? (3) What species they use is Sauce, Salad or chutney (4) What WFPs they use as raw food (5) what wild herbal drinks **they take**? (6) what wild edible seeds **they** collect **and use**? (7) Do you collected or still collecting WFPs for marketing purposes? (8) **How frequently you use the plant in a season?** (9) What is the name of WFPs in your language? (10) Which part you use (11) What recipes you prepare? (12) Which one is the best season of collection? (13) What traditional dish has this WFPs? **If not now, have they such experiences in the past please mention?** All the data based on those questions were arranged in the tabulated form (Table 3). After interviewing 4 people in each village a short field survey along with the interviewees were arranged to collect the available WFPs.

Collected plants specimens were identified with the help of the Flora of Pakistan [43], Wild plants of the **Swat Valley** [44] and finally plants names were cross checked against the Plant List database (2019) [45]. Plants uses were also compared for **comparison and authentication purposes** with previous studies of [14,17,20-27,44].

**Table 1.** Geographical position of the studied **21villages in 7 Tehsils of the studied area.**

S N o	Tehsil Name	Populatio n	Tribes	Studied Villages	Longitude N	Latitude	Altitude (meter)
1	Utmankhel	107,356	Shamozai	Arang Bagh	34 42 49.42 N	71 39 13.01 E	1005
				Taoheed Abad	34 43 21.73 N	71 41 38.56 E	1156
				Ghazi Baba	34 43 39.08 N	71 39 57.31 E	941
2	Barang	76,558	Aseel	Kamal Dara	34 38 02.82 N	71 36 17.07 E	906
				Nazar Mina	34 40 07.65 N	71 36 02.20 E	1013
				Targhao	34 37 47.60 N	71 42 07.79 E	688
3	Khar	247,510	Alizai, Mamund & Salarzai	Batai	34 42 23.92 N	71 35 32.97 E	994
				Shinkei	34 42 56.00 N	71 34 00.74 E	931
				Saramina	34 41 46.70 N	71 32 26.70 E	963
4	Salarzai	268,517	Salarzai & Mashwani	Dara	34 48 55.51 N	71 30 50.10 E	964
				Gabar Cheena	34 54 52.93 N	71 30 10.15 E	1276
				Tofan Shah	34 53 05.17 N	71 31 36.50 E	993
5	Chamarkand	2,868	Sahibzad, Molan	Karkani	34 44 45.15 N	71 18 46.86 E	1161
				Kotkai	34 43 21.57 N	71 20 53.18 E	1060
				Lar Chamarkan	34 41 12.54 N	71 12 45.37 E	1057
6	Nawagai	79,002	Safis & Miangan	Nawagai	34 40 07.88 N	71 17 02.82 E	959
				Srogato Miangan	34 40 32.89 N	71 17 48.55 E	1004
				Khanano kalay	34 39 45.39 N	71 17 39.80 E	1032
7	Mamund	311,873	Mamun & Wara	Barkhalozo	34 51 14.67 N	71 25 41.36 E	1185
				Umarai	34 45 58.62 N	71 26 13.95 E	955

	Mamund	Mamund			
		Meena	34 51 52.66 N	71 24 13.47 E	959

**Table 2.** Frequencies of Age groups and literacy levels of the informants in the study area.

Age groups	No. of informants	Percentage	Literacy level	No. of informants	Percentage
17-27	7	8.33	Illiterate	39	46.43
28-37	9	10.71	Primary	21	25
38-47	16	19.05	Middle	13	15.48
48-57	15	17.86	Secondary	7	8.33
58-67	13	15.48	University	4	4.76
68-77	15	17.86			
78-85	9	10.71			

### 2.3. Data Analysis

#### Classification of WFPs into various food categories

All WFPs were grouped into different food categories based on the consumption mode following [3]. Those plants species cooked as food were categorized as vegetables for example *Caralluma tuberculata*, *Malva neglecta*, *Digera muricata* etc. Species which were consumed without cooking were classified in the category of fruits dry or fresh i.e *Ficus carica*, *Morus alba*, *Celtis caucasica*. Sauce, Salad or chutney species use while mixed with spices and salts for example *Mentha longifolia*, *Mentha royleana*, *Zanthoxylum armatum* etc. *Salvia moorcraftiana*, *Saccharum bengalensis* and *Silene conoidea* were considered as raw food species. Those whose parts were being consumed in raw form other than fruits without cooking.

#### Relative frequency citation (RFC)

WFPs related data, collected during questionnaire survey were also analyzed qualitatively via Relative Frequency Citation Index to highlight the local significance of each WFP species in the region following [5,46].

$$RFC = \frac{FC}{N} (0 < RFC < 1)$$

where FC denotes the number of informants mentioning a specific WFP species, while N shows the total number of informants interviewed during the survey.

## 3. Results and Discussion

### 3.1. Tribal Food System and WFPs

Tribal people have a unique and simple food system mainly established on WFPs, dairy products and cereal crops they cultivate in their fields. Almost each family in the study area rare domestic animals (sheep, goat, cow or buffalo) to fulfil their dairy requirements [47]. They customarily collect WFPs, while grazing their animals. They usually have a piece of land where they cultivate local vegetables and crops. They prepare and consume various kinds of cultural foods from these entire three main above-mentioned sources. Some of the famous simple foods of this belt include the Jawaro Neeny (roasted corn seeds), the Ghanamo Neeny (wheat grains are roasted and then a little brown sugar is added to form small balls), Dhal (grinded wheat grains are boiled with brown sugar and cow oil), Gongrhi (wheat grains are boiled and then used as food) Shedano rotay (wheat flour mixed with cow oil and *Carthamus oxyanthus* seeds and a bread is formed in Tandoor) and Kakori (wheat flour mixed with peanuts, resins, walnuts, coconut and sugar and a special type of bread is formed). Kakori is prepared mostly when the infants start walking for first time. Ghunzakhi (wheat flour mixed with vegetable oil, sugar and *Cuminum cyminum* seeds) it is a special type of sweet prepared and gifted mostly to women when they go to in law house from mother house. The old tribal people cook lentils and pulses on a unique traditional

tribal style, when the dish become prepared a cup or more of cow oils are added. This dish is offered on special cultural gatherings and customs. Ashar is one among such cultural gatherings and customs. Ashar is centuries-old tradition of Pakhtuns in which members of local communities gathers to help each other's during their work without consideration of return, monetary or any other favor. Unfortunately, in recent era this important cultural heritage is on the verge of extinction due to urbanization, modernization and globalization. These traditional foods are considered an important figure and significantly contributes to the tribal food system. Tribal people of the study area living in valleys or across piedmonts collect WFPs to fulfill their food requirements. They are wholly or partially dependent on WFPs resources.

Data on WFPs, i.e. botanical name, local name, family, used parts, habit, mode of utilization, marketing, use reports, relative frequency of citation and the previous literature that reported the uses were gathered via questionnaire as well as literature survey. Sixty-three folk taxa belong to thirty-four botanical families were recorded to signify the current WFPs heritage. This great diversity of WFPs reflects the rich panorama of the tribal food system. A high proportion of these WFPs belongs to the family Amaranthaceae and Leguminosae with five species each followed by Rhamnaceae, Rosaceae, Lamiaceae and Polygonaceae each with four species while the Brassicaceae and Moraceae was represented by 3 species each. The most dominant WFP categories include vegetables (27 species), fruits (24 species), chutney or saucees (7 species) and Raw food species with contribution of six species. The vegetable category mainly composed of weeds locally called *Gayyyah* (unwanted plants species occurs in or along crop fields). The traditional communities gather these species for their own as well as animal food purposes.

### 3.2. Traditional knowledge related to gathering WFPs

WFPs were reported to gather from diverse localities i.e. agricultural fields, foothills and forests. Plants diversity and availability varies with seasonal variations. Local people possess traditional knowledge WFPs their seasonal availability and time of collection [48]. Spring (March-May,) and summer (June-October) are the peak seasons of WFPs collection in the region. November-February are the cold months with the absence of the most of WFPs [22] with cold temperature. Leaves and Pot herb grow well in the months of April and August while best season for fruits ranges from June-October. Different vegetable species mostly remains available for 2-9 months whereas certain fruit species such as *Sideroxylon mascatensis*, *Punica granatum*, *Vitis jacquiamontiana*, *Morus*, *Ficus* and *Ziziphus* species availability recorded for fewer months.

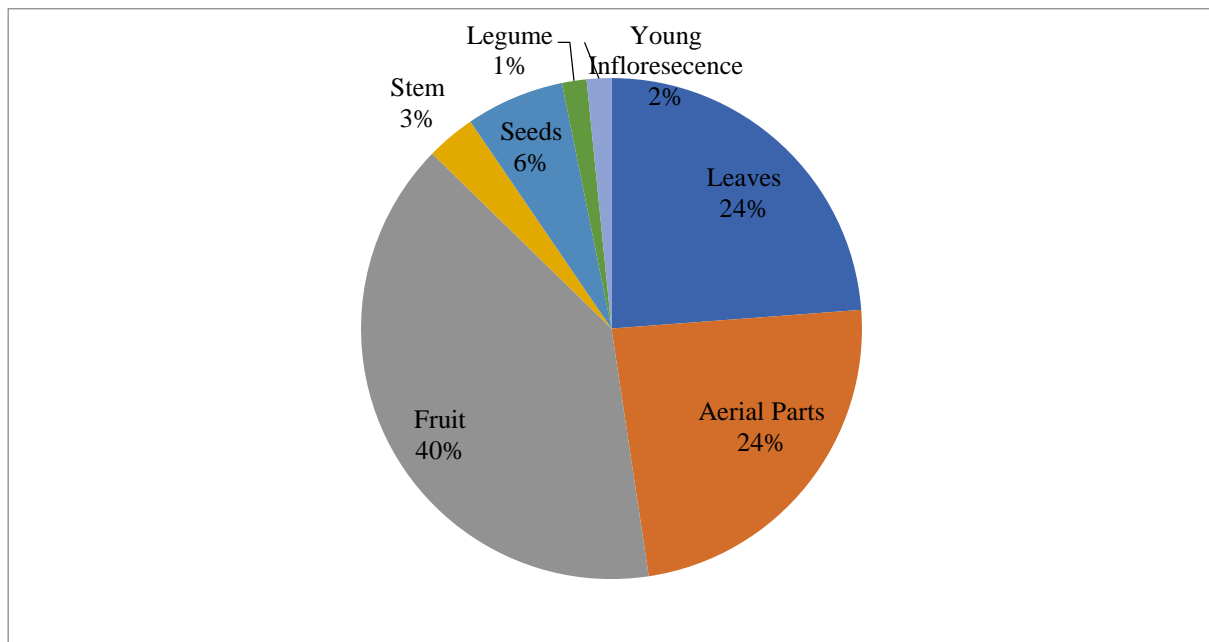
The shepherd communities in search of grasses and fodder for their cattle migrate from one region to another in a cyclic manner. They graze their sheep, goat and cows on hills and mountains and also collect WFPs for their own dietary needs. They are totally or partially dependent on WFPs and homemade dairy products.

One of the old aged participants (81 years old man) belongs to Alizai tribe (Utmankhel) mentioned his views about the role of WFPs in the food system of shepherds and grass collectors with these words "In our times when we used to visit mountains for cattle grazing, grasses and fuel wood collection, and feel hunger, we have to eat *Mentha longifolia* and *Rumex hastatus* leaves with green chilies, onions, tomatoes and *Zanthoxylum armatum* seeds with wheat or barley bread. We grind these over the big stony rocks with the help of small round stones along stream or springs. We were using *Oxalis corniculata* alternate to *Rumex hastatus* leaves sometimes. Some people used to eat brown sugar with wheat or barley bread". In current era this trend of eating WFPs has decreased due to modernized, globalized, and urbanized cultures.

### 3.3. WFPs and the use of its different parts in Traditional cuisines

Our findings showed that fruit are on the top in terms of contribution of the part used that contributed 40% followed by leaves - 24%, aerial parts - 24%, seeds - 4%, stem - 3%, young inflorescence - 2% and legumes - 1% of the total species (Figure 2). The use of various parts varies from species to species and area to area within the region. Leaves and aerial parts are mostly used as vegetables, sauce or as fresh form while the fruits are mostly taken as fresh form. Habit wise,

recorded WFPs are categorized as 57% herb, 22% tree, 19% shrub and 2% climber species.



**Figure 2.** Contribution in terms of WFPs' parts used in the Tribal Food System.

### 3.3.1. Vegetable species

During questionnaires survey local people were asked (1) what wild vegetables species they collect? In response to our question interviewees mentioned 27 species as vegetables throughout the studied villages. According to use reports the most cited and used vegetable species were *Nasturtium officinale* (47), *Oxalis corniculata* (44), *Trifolium repense* (44), *Solanum villosum* (37), *Digera muricata* (31), *Portulaca quadrifida* (29), *Malva neglecta* (28), *Vicia sativa* (27), *Cichorium intybus* (21) and *Caralluma tuberculata* (19). *Nasturtium officinale* locally called as *Termera* is the top used vegetable species in the region and considered as digestive. The species is collected by local communities along the water bodies such as streams, springs, ponds and lakes in the months of March to November. It has been preferred for its unique taste and availability. *Oxalis corniculata* is the most easily available species grown in the shade of other plants or in humid places in the months of March to December. The vast availability, long season and special taste make it one of the most consumed vegetable species. *Trifolium repense* is semi domesticated species grows along water bodies. Its vegetable is consumed widely throughout the region. Chokanr one of the traditional foods formed of this vegetable by its leaves with rice. It is a very popular dish in the whole belt. *Solanum villosum*, *Solanum americanum*, *Descurainia sophia* and *Sisymbrium irio* leaves and young shoots are boiled in concentrated milk and offered to patients as well as older people as digestive food. Similar studies also carried out by different authors on the wild vegetables. Abbas et al [20] reported fifty-three wild vegetable species from the district Kurram. Abbasi et al [23] documented 45 wild vegetables from the Lesser Himalayas Pakistan. In comparison to our study area district Kurram and Lesser Himalayas have great diversity of vegetables because both areas receive great quantity of rainfall and suitable climatic conditions for wild species and particularly WFPs.

Aziz et al., [17] reported twenty-one vegetables used in the remote Yasin and Ishkoman valleys of Gilgit Baltistan while [21] reported 25 wild vegetable species from Northwest Pakistan. Area of Pak-Afghan border is characterized by dry and harsh climatic conditions which has great similarity to climatic conditions of Yasin and Ishkoman valley and Northwest Pakistan. Therefore, these area host low number of wild vegetable species. In another study [26] enlisted 59 wild vegetables from the district Harnai Baluchistan. The traditional communities of district Harnai used various species which have no use trend in our study area such as *Boerhavia procumbence*, *Erodium cicutarium*,

*Fumaria indica* etc. This great diversity in the use of wild vegetable species may be due to unavailability of food resources or due to ethnic differences. Based on these reasons we conclude that use of wild vegetables varies from area to area due to its availability, climatic conditions and ethnography.

### 3.3.2. Fruit Species

Twenty-Four species are being collected from wild and consumed in fresh form by local inhabitants as Fruit. According to the number of use-reports, the most important among the wild fruit species were *Ficus carica* with 64 use reports, followed by *Berberis lyceum* (58), *Myrtus communis* (53), *Olea ferruginea* (48) and *Sideroxylon mascatensis* (48). *Ficus carica* is very common species of the studied region and local people collect its fruits in morning to avoid the hot weather because its fruits come in the hottest months of June and July. *Berberis lyceum* fruits are collected and mostly consumed as **fresh**, some people also make its juice as well and taken for cooling purposes. *Sideroxylon mascatensis* is another important fruit species of the study area. Its forests occur in the **low elevation hills**. People collect *Sideroxylon* ripen fruits in large bottles or pots to avoid pressing and maintaining its shape.

Fruit (acorn) of *Quercus baloot* locally known as *Pergay* is roasted in the hearth, the exocarp is removed and the **endosperm** is consumed. In previous era **ethnobiologists** were unwilling to acknowledge the use of *Quercus* fruits as human food [49] but its consumption is very common in Turkey [50,51] as well as in Iberian Peninsula [49]. Mendez-Baceta et al., [49,52] mentioned that *Quercus* acorns in Gorbeialdea considered as a food for livestock or eaten during food scarcity. In this study we have reported that *Quercus* acorns are not used as staple food, but its roasting is still considered a hobby in the tribal belt and people comes from plain areas to mountains for acorns collection.

Abbasi et al., [14] recorded 35 wild fruits species used by the tribal communities of Lesser Himalaya while [25] recorded 47 species of wild fruits from Swat Valley. The Lesser Himalaya and Swat Valley host great diversity of Plants and receive maximum amount of precipitation during Monsoon compared to the studied region. The Area of Pak-Afghan border at Bajaur receive very little amount of precipitation during Monsoon. These climatic factors distinguish it in term of fruit flora from Swat and Lesser Himalaya. Ahmad and Pieroni [22] studied 31 wild fruits species from Thakhte- Sulaiman Hills, Northwest Pakistan. Thakhte - Sulaiman hills is characterized by dry and harsh climate hosting mostly bushy fruit plants such as *Berberis calliobotrys*, *Ziziphus* species *Cotoneaster microphyllus*, *Cotoneaster minutus*, *Cotoneaster pruinosis* etc on the other hand [53] documented 11 wild fruit species from the district Dera Ismail Khan. Dera Ismail Khan is characterized by very harsh climatic conditions and considered hub for *Phoenix dactylifera* (Dhaki variety) and *Nannorrhops ritchieana* specially in the Abdulkhel and Rahmani Khel areas. Area of Pak-Afghan border at Bajaur have mostly similar plant species such as *Sideroxylon mascatensis*, *Nannorrhops ritchieana* and *Ziziphus* species. Therefore, we conclude that distribution, diversity and consumption of wild fruits species varies from region to region depends on its availability, climatic conditions and cultural knowledge.

### 3.3.3. Sauce or Chutneys

In response to our **questionnaire informants** have reported only six species used in chutney formation. The custom of herbal sauce or chutney formation was not very common throughout the region. *Mentha longifolia* (40), *Mentha royleana* (34), *Cuminum cyminum* (21), *Zanthoxylum armatum* (37), *Allium ampeloprasum* (14), and *Thymus linearis* (7) are the species used in chutney or sauce formation. Interestingly, all these species are aromatic in nature and used in fresh and dried form as well. The local people shade dries these species in their respective seasons for utilization in off seasons of the year. Abbas et al., [20] documented that in district Kurram *Mentha* species are used as Salad while in current study we reported that the local people use it as Salad as well as in Chutney formation. Aziz et al., [17] reported that in Ishkoman and Yaseen valleys of Gilgit Baltistan *Thymus linearis* is used in herbal tea formation while in current study (**Table 3**) we have reported that it is

used as a spice. Thus, we conclude that variation in the use of WFPs in Chutney or sauce formation varies from area to area may be due to ethnography or traditional knowledge.

### 3.3.4. Species used as Fresh or raw form

This category was also not very common in the region. Fresh Raw food species are collected from wild and just masticated or chewed with **takeout** the juice and spitting out the fibers [52] for thirst quenching, appetite suppression or flavor enjoyment. Only six species such as *Saccharum benghalensis* young shoots pulp (17), *Silene conoidea* fruit (22), *Salvia moorcraftiana* young shoots (9) *Indigofera* species aerial parts (3) are consumed in the region. Among these plants species *Carthamus oxycanthus* and *Pinus roxburghii* seeds are used as food. These plants species were not described as raw food species in other studies conducted on the WFPs of Pakistan. *Silene conoidea* is described by [17,20,23] as a cooked vegetable species while in current studied region it was used as raw food species rather than cooked vegetable.

### 3.3.5. WFPs used in Herbal teas, drinks or decoction

*Myrtus communis*, *Mentha royleana*, *Mentha longifolia* are used in herbal tea formation or **decoction**. *Myrtus communis* leaves are boiled with green tea and *Mentha royleana* or *Mentha longifolia* to prepare herbal drinks. These drinks are used to treat vomiting, diarrhea, heart burning and other stomach related problems. The local people **keep it in dry form** in their houses **for off season uses**. *Berberis lyceum*, *Punica granatum* and *Morus nigra* are used in **fresh drinks**. Juices of *Berberis lyceum* and *Punica granatum* are considered important drinks in the area. Indigenous people use these plants for body cooling and thirst-quenching. *Berberis* fruits have very short period of availability and could be available in market **hardly** for 20-30 days. On the other hand, *Punica granatum* fruits are stored by local communities. They store it in grain bins and use it for few months. *Morus nigra* is very common and produce fruits in bulk amount but its juice is not common in study area. Very few informants during interviews reported its use as herbal drink. Aziz et al., [17] mentioned that *Carum carvi* seeds, *Elaeagnus angustifolia* bark and *Thymus linearis* aerial parts are used as seasoning or herbal drinks. In current research work we have reported that aerial parts of *Thymus linearis* are used as herbal spices not as herbal drinks. The other two species *Elaeagnus angustifolia* and *Carum carvi* we have not reported from study area. There is great variation in the climatic conditions and topography of Gilgit Baltistan and Areas of Pak-Afghan border at Bajaur. Gilgit Baltistan occurs in the Karakoram mountain range while Areas of Pak-Afghan border at Bajaur is a part of Hindukush mountains range, it argues that variation in topographic and climatic factor take variation in floral diversity and its traditional uses among the societies.

### 3.4. Cooking and Cuisines summary of WFPs

Various methods for cooking **recipes** WFPs were recorded during interviews with local informants. The traditional communities use WFPs on different ways. The consumption methods and knowledge of these plants they **maintained** from their ancestors. There are different methods used for the preparation of these wild foods depends upon the nature of plants. Wild vegetables i.e. *Amaranthus vridis*, *Amaranthus crissipus*, *Chenopodium album*, *Rumex dentatus*, *Rumex histatus*, *Malva neglecta*, *Digera muricata*, *Nasturtium officinale*, *Lathyrus aphaca*, *Vicia sativa*, *Medicago polymorpha*, *Medicago denticulate*, *Portulaca quadrifida*, *Cichorium intybus*, *Polygonum aviculare*, *Polygonum plebium*, *Solanum villosum*, *Solanum americanum*, *Marsillia* etc are cut into small pieces and boiled in water. After boiling vegetables, onions are fried in oil, then tomatoes and garlic are added respectively [20]. After the addition of garlic special **sort of sauce is** formed on the traditional tribal style. This mixture then locally called as *Dagh* or *Tarka*. Some people also add green chilies depends upon the preferences and taste. Subsequently, the boiled vegetables are added and heated till the **oil poured out on** comes on the top of the **cuisine**. Some vegetables are boiled in concentrated milk [23] such as *Solanum villosum*, *Solanum americanum*, *Descurainia sophia* and *Sisymbrium irio*. Bitter vegetables such as *Caralluma tuberculata* is cut into small pieces boiled in water 2-3 times fried in oil with onion, tomatoes, chilies and condiments. Some people cook *Caralluma* with minced meat (*Keema/Qeema*).

Tribal belt of Pakistan has a unique food system. WFPs are still used in different ways to increase their taste, nutritional values and health benefits. They prepare many traditional cuisines by mixing WFPs with other wild or cultivated vegetables and other foods i.e. rice, meat, chicken handi, qeema, pulses, Indian squash, potato, traditional breads, milk, yogurt, custards etc. Various other products are also prepared of these WFPs i.e. juices, syrups and jams. *Carthamus oxycanthus* seeds are mixed with brown sugar and heated till a flat candy formation take place locally called as *Kaboray* (Caramel Candie).

Guarrera and Savo [10] discussed this tradition in a review article entitled “Wild food plants used in traditional vegetable mixtures in Italy”. Abbasi et al., [23] also mentioned that some of the vegetable species are cooked in mixture with other vegetables or in concentrated milk while working on the wild vegetables of Lesser Himalaya. Abbas et al., [20] documented that “All the seasonal wild vegetables are combined intermittently and a particular dish of seven to ten species is cooked during festivals (Nowruz) in the Shia community” while working on the wild vegetables of district Kurram. Therefore, we elucidate that consumption of WFPs especially wild vegetables in mixture form is an old tradition of human societies to increase their taste, nutritional values and health benefits.

### 3.5. Storage and uses of WFPs in off seasons

WFPs availability during offseason storage and drying is an important method which provide stability to food system throughout the year [22]. In study area number of species are stored by local communities in dried form for the consumption in off seasons such as aerial parts of *Mentha longifolia*, *Mentha royleana* and *Punica granatum* fruits. In ancient times the local people used to store the pomegranate species in grain bins (the grain bins of the old societies were formed of mud), and then they use it during the time of need. *Morus alba*, *Sideroxylon mascatensis* and *Prunus armeniaca* (Kakhta) fruits are dried and used in winter season of the year. *Allium carollianum* leaves in the month of April are collected by the traditional communities to prepare local spices or Masalas in their homes. They shade dried its leaves and then used in dried form with *Curcuma longa* (Korkaman), *Cuminum cyminum* and *Punica granatum* seeds. *Punica granatum* seeds use in spices is a custom of the traditional communities. *Myrtus communis* leaves and fruits are stored in homes and used in lassi and herbal tea for its enticing aroma and appetizing flavor.

### 3.6. Relative Frequency of Citation

In the present study, RFC values ranged from 0.01 to 0.8. The highest RFC was recorded for *Ficus carica* (0.8), followed by *Myrtus communis* (0.7), *Berberis lyceum* (0.7) *Nasturtium officinale* (0.6), *Olea ferruginea* (0.6) (Table 3). High RFC values of certain Wild fruit species showed their abundant use and extensive knowledge among the tribal communities. *Myrtus communis* and *Berberis lyceum* have high RFC values but both species facing conservation threats in the area. The local people have been collecting WFPs from the wild for nutritional and ethnomedicinal purposes since time immemorial. This continuous trend of gathering WFPs has caused alarming decrease in populations of certain species. On the other hand, due to cultural and religious importance of certain species such as, *Ficus carica*, *Olea ferruginea* are being respected and hence distributed abundantly in the region. Therefore, we conclude that highest use for WFPs not only depends on the abundance of the species but also on the local preferences, and its highest nutraceuticals values.

### 3.7. Selling or Marketing of WFPs

During questionnaire we have asked the interviewees that do you collected or still collecting WFPs for marketing purposes? In response they reported ten plants species that are available in the local markets of Bajaur i.e Khar, Pashat, Inayt Kalay, Nawagai, Memola, Chenagai and Tawheed Abad. These 10 marketable species include four wild fruits, five vegetables and one species used as flavoring agent. The fruits include *Sideroxylon mascatensis*, *Berberis lyceum*, *Ziziphus sativa* and *Diospyrus lotus*. *Mentha longifolia*, *Mentha royleana*, *Caralumma tuberculata*, *Spinacia quadrifida* and *Malva neglecta* are the wild vegetables species while *Zanthoxylum armatum* is used as flavoring agent

in various traditional dishes. All these species are available in market in fresh form except *Sideroxylon mascatensis* which's fruits is available in the market in the dried form as well during off seasons. Marketing of WFPs species play important role in the livelihood of the local poor people. Inhabitants of rural areas collect and sell WFPs in local markets for income generation. Abbasi et al., [23] reported that *Dryopteris ramosa*, *Bauhinia variegata*, *Chenopodium album*, *Portulaca quardifida*, *Nasturtium officinale*, *Malva parviflora*, and *Solanum nigrum* are sold in the markets of Rawalpindi and Abbottabad while we have not reported market value for any of these species. According to the findings of [20] wild vegetables species available in the local markets of district Kurram were *Caralluma tuberculata*, *Mentha spicata*, *Lepidium draba*, *Rumex dentatus*, *Portulaca oleracea*, *Malva neglecta*, *Trifolium repens*, *Stellaria media*, and *Nasturtium officinale*. In current study we have documented *Caralluma tuberculata* (Figure 3), *Malva neglecta* and *Mentha* species which is similar between both the study areas. *Rumex dentatus*, *Malva neglecta*, *Trifolium repens*, *Stellaria media*, and *Nasturtium officinale* are the species very common and used by the tribal communities as vegetable but we have not reported and not observed in the markets.

### 3.8. Management and conservation of wild Food plants

The territory has great diversity of wild fruits species. *Ficus carica*, *Ficus palmata*, *Morus alba* and *Morus nigra* (Figure 3) are the wild fruits species occurs in abundance across the region. Unfortunately, every year a huge mass of these fruits is lost. No or very little number of people dry and store these fruits for consumption in other seasons of the year when these fruits are not available. There is no plan for the management and use of these species.

*Myrtus communis* occurs in study area in small patches presently as it's collected by the local people continuously due to its unique aroma and taste and hence its population is decreasing [54] with an alarming rate. *Berberis lyceum* is another important wild fruit species occurs in the hilly parts of the study area and facing the problem of uprooting. Indigenous communities use its roots for body cooling, stomach and wound healing purposes. They import its roots into urban areas and local herbal shops where they sell it with its market name Ziar largay. *Prunus armeniaca* another important fruit tree of the study area. It has a special vegetation patch of about 500 trees at the Batai hill. Every year people collect its fruit for their consumption. Unfortunately, due to urbanization this forest patch facing the problem of overexploitation. Its beautiful brown color hard wood is considered very favorite for furniture. Road construction during 2019 in the forest area was another serious threat for the conservation of *Prunus* forest. Other species facing conservation problems in the region is *Nannorrhops ritchieana* uprooted by Porcupine [37], *Sagerati thea*, *Sideroxylon mascatensis*, *Rosa moschata*, *Myrsine africana*, *Ziziphus nummularia*, *Ziziphus jujuba*, *Ziziphus oxyphylla*, *Zanthoxylum armatum* and *Vitis jacquemontii* are the species facing conservation problem due to overexploitation, soil erosion and climatic changes.



**Figure 3.** (a) *Morus nigra* fruits (b) *Morus alba* (c) A young man collecting Mazri fruits (d) *Caralluma tuberculata* (e) A young man collecting wild vegetables (f) *Carthamus oxycanthus* seeds.

Table 3. Wild food plants (WFPs) gathered and consumed in the tribal belt of Bajaur.

S. No	Botanical names of WFPs	Local names of WFPs	Family	HB	Part used	Recipes and mode of Utilization in Cuisines	Contribution in Tribal Food System (use in other cookeries)	Coll. Time	Marketing	UR	RFC	Previously reported From Pakistan for food usages
1	<i>Allium carolinianum</i> DC	Ogai	Amaryllidaceae	H	Leaves	Leaves are used as salad or fried in oil with Tomato and Red chilies and mixed with different cousins	i. Chicken Handi, ii.Traditional bread iii. Flavoring agent	F-Jun	+	14	0.17	
2	<i>Amaranthus crassipes</i> Schltld.	Churlai	Amaranthaceae	H	Leaves	Leaves are boiled in water and then fried in oil with tomato, onion and red chilies.	i. Indian Squash ( <i>Praecitrullus fistulosus</i> )	Ap-D	-	8	0.10	
3	<i>Amaranthus viridis</i> L	Ganar	Amaranthaceae	H	Leaves	Leaves fried in oil with tomato, onion and red chilies.	i. Pulses ii. Indian squash	Ap-D	+	23	0.27	[20,21,23,24,26]
4	<i>Asparagus officinalis</i> L		Asparagaceae	S	Aerial parts	Leaves boiled in water and then fried in oil with tomato, onion and red chilies.		Jun-Jul	+	13	0.15	
5	<i>Berberis lycium</i> Royle	Koaray	Berberidaceae	S	Fruit	Taken as fruit	i. Juices	Mar-Nov	+	58	0.69	[1,23,25]
6	<i>Caralluma tuberculata</i> N.E.Br.	Pamankay	Asclepediaceae	H	Stem	Leaves fried in oil with tomato, onion and red chilies.	i. Qeema ii. Meat	Jun-Nov	-	19	0.23	[20-22,26]
7	<i>Carthamus oxyacantha</i> M.Bieb	Kareza	Asteraceae	H	Seeds	Seeds are cooked in bread and then the bread is creamed with desi oil	i. Caramel candies	Jul-Sep	-	13	0.15	
8	<i>Celtis australis</i>	Tagh	Canabaceae	T	Fruit	Taken as fruit		Mar-Jun	-	27	0.32	[22,24,25]

<i>L</i>												
9	<i>Chenopodium album L</i>	Sarmay	Amaranthaceae	H	Leaves	Leaves boiled in water and then fried in oil with tomato, onion and red chilies.	i. Pulses ii. Yogurts	Mar-Jun	-	11	0.13	[17,20,22,23,26]
10	<i>Cichorium intybus L.</i>	Kashni	Asteraceae	H	Leaves	Leaves boiled in water and then fried in oil with tomato, onion and red chilies.	i. Pulses ii. Rice	Apr-Jul	-	21	0.25	[21,23,26,27]
11	<i>Cuminum cyminum L</i>	Zeera	Apiaceae	H	Seeds	Seeds used for aroma and taste in various traditional foods	i. Meat ii. Pulses iii. Rice iv. Custard etc.	Apr-May	-	19	0.23	
12	<i>Descurainia sophia (L.) Webb ex Prantl</i>	Jenjar	Brassicaceae	H	Leaves	Leaves boiled in water and then fried in oil with tomato, onion and red chilies.	i Milk ii Pulses	Mar-Jun	-	8	0.10	[26]
13	<i>Digera muricata (L.) Mart.</i>	Sur gulay	Amaranthaceae	H	Leaves	Boiled leaves are fried in oil with tomato, onion and red chilies.	i Pulses ii Potato iii Rice	Jun-Oct	-	31	0.37	[23]
14	<i>Diospyros lotus L.</i>	Tor amlook	Ebenaceae	T	Fruit	Taken as fruit		Oct-Jan	+	34	0.40	[24,25]
15	<i>Ficus carica L.</i>	Inzar	Moraceae	T	Fruit	Taken as fruit		Jun-Aug	+	64	0.76	[14,24,25]
16	<i>Fragaria nubicola (Lindl. ex Hook.f.) Lacaita</i>	Da zamkay toot	Saxifragaceae	H	Fruit	Taken as Fruit	i. Jams, ii. Local Ice iii. Custards, iv. Sweets,	May-Sep	-	22	0.26	[14,25]
17	<i>Indigofera spp</i>	Gedarghog	Leguminoseae	S	Aerial parts	Flowers +Leaves are taken as raw		Mar-May	-	3	0.04	
18	<i>Lathyrus aphaca L.</i>	Korkaman	Leguminoseae	H	Aerial parts	Boiled leaves are fried in oil with tomato, onion and red chilies.	i Pulses ii Rice	Mar-Jun	-	17	0.20	[21,23]

19	<i>Malva neglecta</i> Wallr	Panderak	Malvaceae	H	Leaves	Boiled leaves are fried in oil with tomato, onion and red chilies.	Mixed with i. Rice ii. Potato iii. Pulses iv. Yogurt v. Beef	Mar-Nov	+	28	0.33	[20,21]
20	<i>Marsilea quadrifolia</i> L	Chopatra	Marsilleaceae	H	Leaves	Boiled leaves are fried in oil with tomato, onion and red chilies.	i Rice ii. Potato iii. Pulses	May-Jul	-	3	0.04	
21	<i>Medicago polymorpha</i> L.	Speshtaray	Leguminoseae	H	Aerial parts	Boiled leaves are fried in oil with tomato, onion and red chilies.	i. Rice ii. Potato iii. Pulses iv. Yogurt v. Beef	Mar-Jun	-	17	0.20	[20,21,23]
22	<i>Mentha longifolia</i> L	Podina	Lamiaceae	H	Aerial parts	Leaves and young shoots are taken as salad	i. Flavoring agent ii. Rice iii. Custards iv. Sweets etc.	Mar-Nov	+	40	0.48	[17,20,21,26]
23	<i>Mentha royleana</i> Wall. ex Benth	Enalay	Lamiaceae	H	Aerial parts	Leaves and young shoots are taken as salad	i. Flavoring agent ii. Rice iii. Custards iv. Sweets etc.	Mar-Nov	Y	34	0.40	[20,21]
24	<i>Morus nigra</i> L	Tor toot	Moraceae	T	Fruit	Taken as fruit	i. Juices ii. James iii. Syrup	Apr-Jul	-	23	0.27	[14,24,25]
25	<i>Morus alba</i> L	Spin toot	Moraceae	T	Fruit	Taken as fruit	i. Juices ii. James	Apr-Jul	-	28	0.33	[14,24,25]
26	<i>Myrsine africana</i> L.	Manrogaya h	Primulaceae	S	Fruit	Taken as fruit		Jul-Sep	-	5	0.06	[14,24,25]
27	<i>Myrtus communis</i> L.	Myrtaceae	Shrub	S	Fruit	Taken as fruit	i. Flavoring ii. Rice iii. Curd iv. Milk v. Custards vi. Sweets etc.	Sep-Nov	+	53	0.63	[54]
28	<i>Nannorrhops</i>	Mianzarai	Arecaceae	S	Fruit	Taken as fruit		Sep-Oct	-	11	0.13	[20,53]

	<i>ritchieana</i> (Griff.) Aitch											
29	<i>Nasturtium officinale</i> R. Br	Tarmera	Brassicaceae	H	Leaves	Boiled leaves are fried in oil with tomato, onion and red chilies.	i. Potato ii. Pulses	Mar-Nov	-	47	0.56	[20,21,23]
30	<i>Olea ferruginea</i> Wall. ex Aitch	Khona	Oleaceae	T	Fruit	Taken as fruit		Aug-Oct	-	48	0.57	[14,22,24,25]
31	<i>Opuntia dillenii</i> (Ker Gawl.) Haw.	Tafnra		S	Fruit	Taken as fruit		Sep-Oct	-	5	0.06	[14,25]
32	<i>Oxalis corniculata</i> L.	Trewakay	Oxilidaceae	H	Aerial parts	Boiled leaves are fried in oil with tomato, onion and red chilies.	i. Rice ii. Potato iii. Pulses	Mar-Dec	-	44	0.52	[20,21,23,25, 26]
33	<i>Papaver rhoeas</i> L	Reday	Papaveraceae	H	Leaves	Boiled leaves are fried in oil with tomato, onion and red chilies.	i. Rice ii. Potato iii. Pulses	Mar-May	-	5	0.06	
34	<i>Pinus roxburghii</i> Sarg.	Nakhtar	Pinaceae	T	Seeds	Seeds are eaten as raw		Dec-Feb	-	8	0.10	
35	<i>Prunus armeniaca</i> L	Zardalo	Rosaceae	T	Fruit	Taken as fruit	i. James	May-Jun	-	21	0.25	[25]
36	<i>Polygonum aviculare</i> L	Bandakay	Polygonaceae	H	Aerial parts	Boiled leaves are fried in oil with tomato, onion and red chilies.	i. Rice ii. Potato iii. Pulses	Mar-Nov	-	8	0.10	[23,26]
37	<i>Polygonum plebejum</i> R. Br.	Bandakay	Polygonaceae	H	Aerial parts	Boiled leaves are fried in oil with tomato, onion and red chilies.	i. Rice ii. Potato iii. Pulses	Mar Nov	-	6	0.07	[20]
38	<i>Portulaca quadrifida</i> L.	Warkharay	Portulacaceae	H	Aerial parts	Boiled leaves are fried in oil with tomato, onion and red chilies.	i. Beans ii. Rice iii. Potato iv. Pulses	Jun-Sep	+	29	0.35	[21-23]
39	<i>Punica granatum</i> L.	Anangoray	Punicaceae	T	Fruit	Taken as fruit	i. Juices ii. Spices iii. Rice	Sept-Oct	-	27	0.32	[22,24,25]
40	<i>Quercus baloot</i>	Serai	Fagaceae	T	Fruit	Taken as fruit	i. Fried mixed	Dec-Feb	-	8	0.10	[20]

Griff						with Corn grains rarely						
41	<i>Rosa moschata</i> Herrm	Khwrach	Rosaceae	S	Fruit	Taken as fruit		Aug-Oct	-	4	0.05	[14,20,22]
42	<i>Rubus fruticosus</i> G.N.Jones	Karwara	Rosaceae	S	Fruit	Taken as fruit	i. Juices	Jul-Sep	-	23	0.27	[17,25]
43	<i>Rubus ulmifolius</i> Schott	Karwara	Rosaceae	S	Fruit	Taken as fruit	i. Juices	Jul-Sep	-	8	0.10	[14,22]
44	<i>Rumex hastatus</i> D. Don	Tarookay	Polygonaceae	H	Leaves	Boiled leaves are fried in oil with tomato, onion and red chilies.	i. Rice ii. Potato iii. Pulses	Mar-Jun	-	15	0.18	[21,23]
45	<i>Rumex dentatus</i> L.	Shalkhay	Polygonaceae	H	Leaves	Boiled leaves are fried in oil with tomato, onion and red chilies.	i. Rice ii. Potato iii. Pulses	Mar-Nov	-	11	0.13	[17,20,21,23]
46	<i>Saccharum bengalense</i> Retz	Sharghashay	Poaceae	H	Young inflorescence	Young inflorescence taken is raw before blooming		Mar-Apr	-	17	0.20	
47	<i>Sageretia thea</i> (Osbeck) M.C. Johnst	Momanra	Rhamnaceae	S	Fruit	Taken as fruit		May-Jun	-	37	0.44	
48	<i>Salvia moorcroftiana</i> Wall. ex Benth.	Kharghwa g	Lamiaceae	H	Stem	young stem used as raw food		Mar-Apr	+	9	0.11	[22]
49	<i>Sideroxylon mascatense</i> (A.DC.) T.D.Penn.	Gorgora	Sapotaceae	T	Fruit	Taken as fruit		Jun-Jul	-	43	0.51	[22,53]
50	<i>Silene conoidea</i> L.	Mangotay	Caryphylaceae	H	Fruit	Taken as fruit		Mar-May	-	22	0.26	[17,20,23]
51	<i>Sisymbrium irio</i> L.	Khobkalan	Brasssicaceae	H	Leaves	Taken as fruit	i. Rice ii. Potato iii. Pulses iv. Milk	Mar-Jun	-	18	0.21	[20,26]
52	<i>Solanum americanum</i> Mill	Kachmacho	Solanaceae	H	Aerial parts	Leaves boiled in water and then fried in oil with	i. Rice ii. Potato iii. Pulses	Mar-Sep	-	7	0.08	[21,22,25]

						tomato, onion and red chilies.						
53	<i>Solanum villosum</i> Mill.	Kachmacho	Solanaceae	H	Aerial parts	Leaves boiled in water and then fried in oil with tomato, onion and red chilies.	i. Rice ii. Potato iii. Pulses	Mar-Sep	-	37	0.44	[20]
54	<i>Stellaria media</i> (L.) Vill.	Khorenakay	Caryophyllaceae	H	Aerial parts	Leaves boiled in water and then fried in oil with tomato, onion and red chilies.	i. Rice ii. Potato iii. Pulses	Mar-May	-	13	0.15	Abbas et al., 2020; Abbasi et al 2013b
55	<i>Thymus linearis</i> Benth.		Lamiaceae	H	Aerial parts	Aerial parts used in spices	i Meat ii Pulses iii Rice iii Custard iv. Spices etc.	May-Oct	-	23	0.27	[22]
56	<i>Trianthema portulacastrum</i> L.	Ghana	Amaranthaceae	H	Leaves	Leaves boiled in water and then fried in oil with tomato, onion and red chilies.	i. Potato	Jun-Sep	-	13	0.15	
57	<i>Trifolium repens</i> L	Shaftal	Leguminoseae	H	Aerial parts	Leaves boiled in water and then fried in oil with tomato, onion and red chilies.	i. Rice ii. Potato iii. Pulses iv. Yogurt	May-Oct	-	44	0.52	[20]
58	<i>Vicia sativa</i> L	Arwarai	Leguminoseae	H	Legume	Legume is taken as raw or fried in oil with tomato, onion and Red chilies.	i. Meat ii. Spinach iii. Rice iv. Indian squash	Mar-Jun	-	27	0.32	[17,26]
59	<i>Vitis jacquemontii</i> R. Parker	Gedarkwar	Vitaceae	L/S	Fruits	Taken as fruit	i. Juices	Jul-Aug	+	13	0.15	[14,25]
60	<i>Zanthoxylum armatum</i> DC	Dambara	Rutaceae	T	Seeds	Seeds are powdered and then mixed with curd, Mint leaves,	i. Curd ii Pulses iii Rice iii Custard	Mar-Jun	-	37	0.44	[14,24,25]

						tomato and red chilies to form Chutney	iv. Spices etc.					
61	<i>Ziziphus oxyphylla</i> Edgew	Enalai	Rhamnaceae	S	Fruit	Taken as fruit		Aug-Nov	+	19	0.23	[14,22,24,25]
62	<i>Ziziphus jujuba</i> Mill	Markhanra i	Rhamnaceae	T	Fruit	Taken as fruit		Aug-Sep	-	12	0.14	[14,22,25]
63	<i>Ziziphus nummularia</i> (Burm.f.) Wight & Arn	Beera	Rhamnaceae	T	Fruit	Taken as fruit		Oct-Nov	-	17	0.20	[22,24,25,53]

Hb = Habit, H = Herb, S = Shrub, T = Tree, Coll. Time = Collection Time, UR = Use reports, RFC = Relative Frequency of Citation, + = Marketable, & \_ = Nonmarketable.

## Conclusions

The current research work was the first attempt to study the contribution of WFPs in the food system of the tribal belt of Pakistan-Areas of Pak-Afghan border at Bajaur. The local inhabitants were economically poor and they most of the time utilize local food resources at home. The results showed that WFPs have been and still collected and consumed in the region. In addition to nutritional values ten species have market values and contributes to the economy of local communities. Uses of *Carthamus oxycanthus* (Figure 3) & *Pinus roxburghii* seeds and *Marsillea* leaves were novel reports for the gastronomy of Pakistan after comparing with other region of the country. *Myrtus communis*, *Berberis lyceum*, *Prunus armeniaca*, *Nannorrhops ritchieana*, *Zanthoxylum armatum* and *Vitis jacquemontii* etc. are the species facing conservation problem due to overexploitation, soil erosion and climatic changes.

The knowledge related to the consumption of WFPs in younger generation is decreasing in the tribal societies. Therefore, more studies are needed to conserve this important cultural gastronomic heritage of the studied region where the modernization, urbanization and industrialization are on the peak. We believe that this study will play a crucial role in the conservation and fostering of the traditional knowledge of WFPs cooking and consumption.

**Authors' contribution:** Abdullah carried out the field work and prepared the first draft of the manuscript. SMK contributed in the study design analysis and supervised the project.

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